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Art. XVI.—*Additional Notes on Australites: Darwin Glass.*

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[With Plate XXIII.].

(Read November 11th, 1915).

Since my notes dated 4/7/13, and published in Records of the Geological Survey of Victoria, Vol. III., Part 3, were penned, further examples of Australites have come to hand that demand attention as affording valuable evidence of the manner in which they were formed. Among those dealt with are probably the smallest yet described; their importance, however, is not to be measured by their size, for the series, as illustrated, affords useful data not hitherto obtained. Apparently they show the progressive steps by which the original drop of fluid glass became moulded into the symmetrical australite. The several examples show individuals arrested at different stages of the process. The glass of which they consist having become rigid in some cases at an early stage, in other cases at later stages. In three examples they are deformed, and appear to have reached the surface of the earth while still in a semi-plastic condition.

The smaller figures in the illustration are natural size. The larger figures are the same objects magnified two diameters.

Fig. 1 shows an early stage, the drop of glass has assumed a discoidal form, there is a short line in the centre of the upper surface, and the outer edge of the rim is turned slightly up. There must have been a stage preceding this in which the molten glass was drop like. In Fig. 1 the thin short line is the only indication of a core. It seems as though a rotary impulse had been imparted to the drop of molten glass, and that the small body through loss of heat became rigid at this stage, and fell to the surface of the earth.

Fig. 2 shows an advance on Fig. 1, for a small conical pit has formed in the centre of the upper surface, but there is still no actual core present. This example may have rotated longer while still in a molten or plastic condition than was the case with Fig. 1. The rim has become more defined also.

Fig. 3 shows an advance on Fig. 2, and a small core appears in the centre, where only a pit existed in Fig. 2. This example may have rotated still more than was the case with Fig. 2 before the glass became rigid.

Fig. 4 shows still further development; the core became enlarged, and the rim became more strongly developed before the glass lost its viscosity.

Fig. 5. This example has been broken across, but enough remains to show the core much enlarged, and the rim to have become much more like that of normal australites, while the proportions of the rim to the core approximate more nearly to these found in normal australites. There is one feature, however, in this example which differentiates it from the usual forms, and that is its thickness, which is only $1\frac{1}{2}$ millimetre, and quite out of proportion to its diameter (15 millimetres) as compared with normal types. Although so thin that the glass is nearly transparent, there are the usual rudely spiral ridges on the underside. Comparison of the above forms with normal types of australites leaves no doubt as to both being formed in the same way, though in the case of those now dealt with conditions seem to have prevailed which caused some modification in their forms, for they are exceptionally thin as compared with their diameter. All the above examples evidently reached the surface in a rigid condition, though in different stages of development. Possibly this may have resulted from the varying distances above the surface at which their careers began. Rapid rotation would be necessary to produce such forms before rigidity set in.

Fig. 6 shows a deformed example. It was apparently in an early stage of development (between Figs. 1 and 2) when it reached the surface in a semi-plastic condition, with the result that impact with the soil or some hard object caused an interference with its symmetrical form, and distorted it as shown in the plate.

Fig. 7 shows a symmetrical ovoid form, with a centre or core less regular. It belongs to one of the aberrant types such as occur in the larger australites. It is quite symmetrical at its periphery, and evidently has not had its shape interfered with by impact with another body, but may have resulted from rotary action.

Fig. 8 is remarkable as being cup-shaped, and is the only example the writer has seen approaching this form. In its present state the cup has been flattened. This also appears to be an example that reached the surface while still in a semi-plastic condition, with the result that it collapsed on its side when it came in contact with the ground.

Fig. 9 is the smallest of the series, weighing only .2044 gram. It is deformed like Fig. 6 and apparently reached the earth in an early stage of formation and while still semi-plastic.

Fig. 10 is an example of Pele's Tears, cigar-shaped, and consisting of very scoriaceous grey pumice with a smooth skin on the surface, but so friable as to readily crush between the finger and thumb.

Fig. 11 is a dumb-bell shaped Pele's Tear similar to Fig. 10 in material. These examples of Pele's Tears are for comparison with some of the forms of australites. They are of volcanic origin, being found on the flanks of Kilauea, Sandwich Islands, and were presented to me by Professor Moore, of the State College, Pennsylvania, U.S.A.

Figures 1 to 9 suggest that the small australites may owe their form to rotary action. There is no process or remains of such a process around the periphery as would favour the theory of their forming part of a bubble, and here I may say that the theory that australites were the lower portions of bubbles was suggested by the hollow sphere 2 inches across in the Melbourne National Museum, and by other hollow examples. Further, on making sections across button-shaped examples, the broken edges marked *c* in the photographic illustrations in Bulletin No. 27 of the Geological Survey of Victoria and the flow structure appeared to confirm this view. The broken edges at *c* may, however, have been accidental.

The flow structure as shown in the photographic plates in the above Bulletin seem difficult to explain if australites were formed by rotary action, and the relation of the rim to the core seems a difficulty, for the Bulletin illustrations above referred to appear to indicate that the centre or core was first formed, and then the rim, while the examples of small australites here dealt with appear to imply the reverse, or that these bodies at the beginning were disc-like, and all rim, and that a portion of the centre of the disc was absorbed to form the core, and that this core increased in size at the expense of the rim by continued rotary movement until the glass became rigid. The formation of hollow spheres by a rotary process also presents difficulties, and the presence of perfectly spherical bubbles so common in the cores of australites is also difficult to understand if the core was rapidly rotated while yet in a viscous condition.

If these small objects were moulded by rotary movements, the rotation must have been about an axis at right angles to the plane of the disc, and if so then the more abnormal types such as ovoidal, elongated and dumb-bell forms must also have resulted from rotation about the shorter axes of these bodies, and in planes corresponding to the plane of the disc.

Professor Grant,[1] Dr. Summers,[2] Professor Skeats,[3] and others have suggested that the forms of australites are due to rotary action, and these small examples certainly appear to favour this view.

Darwin and the Rev. W. B. Clarke were the first to suggest that the forms of australites were due to rotary movement.

It is for the physicist now to demonstrate by actual experiment whether molten glass by rotation would form such bodies, and also whether the flow structure so well shown in sections of australites could be produced by rotary action alone.

Experiments might result in determining how long such small bodies would remain plastic in the atmosphere, and in this way the height above the surface at which they commenced their career could be determined, also the speed of the revolutions necessary to produce these forms from molten glass before it lost its original viscosity and became rigid.

Should such experiments prove that australites owe their form to rotary movement, and that they are not the blebs of bubbles, then the problem of their distribution remains still to be solved, and in this connection it may be mentioned that in the auriferous alluvial gold working at Stony Creek, Grampians, Victoria, an irregular fragment of obsidian 2 inches long and ¾ inch broad, finely pitted on the surface and showing flow structure, was found in the wash-dirt associated with examples of australites. It is somewhat water worn and appears to have lain long in the gravel. A chip has quite recently been detached which shows its vitreous nature. The specimen belongs to Mr. Ferguson, an officer of the Geological Survey, and it is in the Geological Survey Museums, Melbourne. The same means that transported this fragment from its volcanic source could have also transported the australites found with it.

In the groove between the core and the rim of some australites there is a white substance that under the lens appears to be silica. Dr. Du Toit, of the South African Geological Survey, drew my attention to fine lines that radiate from the centre of the underside of some of the button-shaped australites. This feature occurs on several examples.

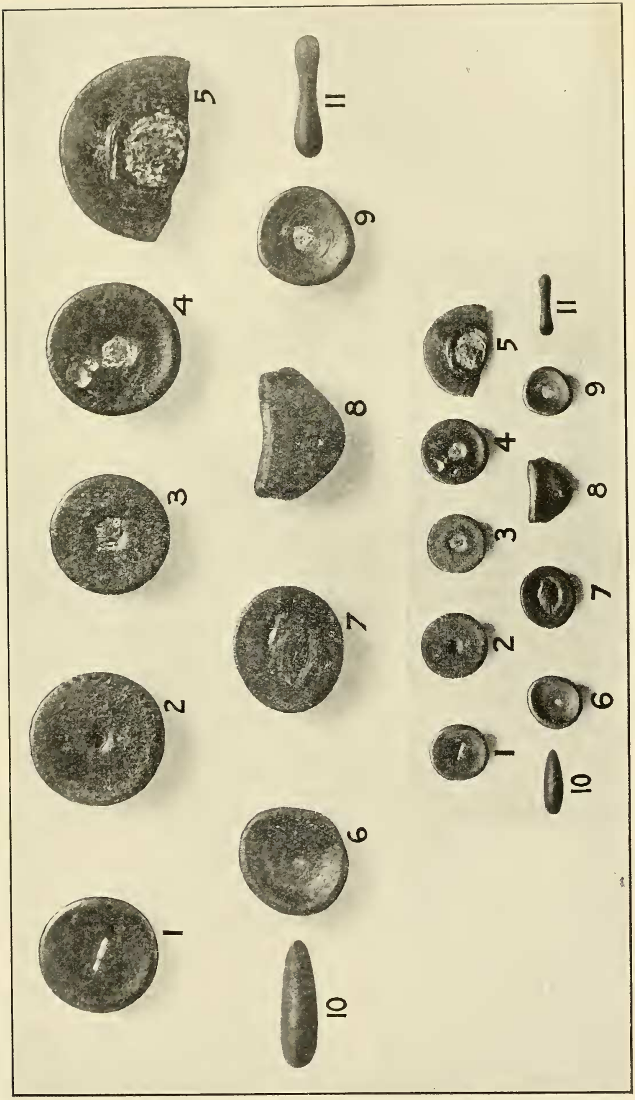
List of Localities of Australites shewn on Plate.

Fig. 1.	Mt. William Goldfield,	Grampians,	Victoria.	
„ 2.	do.	do.	do.	do.
„ 3.	do.	do.	do.	do.

1 Proc. Roy. Soc. Victoria, vol. xxi., part ii., p. 413.

2 Australian Association for the Advancement of Science, vol. xiv., Melbourne, 1913.

3 Proc. Roy. Soc. Victoria, vol. xxvii., part ii., p. 363.



Small Australites and Pele's Tears.

Inset natural size. Other figures magnified 2 diameters.